AVATARS, PEDAGOGICAL AGENTS, AND VIRTUAL ENVIRONMENTS: SOCIAL LEARNING SYSTEMS ONLINE

By

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ABSTRACT

This paper presents a review of literature that introduces major concepts and issues in using avatars and pedagogical agents in first- and second-person virtual environments (VEs) for learning online. In these VEs, avatars and pedagogical agents represent self and other learners/participants or serve as personal learning "guides". The paper offers insights into the relationship of online VEs and their components to computer games and discusses the roles of the Computer as Social Actor (CASA) paradigm, anthropomorphism, ethopoeia, and homophily in these learning environments. It defines and illustrates the terminology and conventions used in VE technology, discusses social aspects of human learning in online VEs, reviews relevant literature, introduces theories relevant to designing these environments, and suggests some models for research to advance the currently limited knowledge of how, why, when, and for whom these online learning environments may be most effective.

Keywords: Avatars, CASA Paradigm, Collaborative Learning, Human-Computer Interaction, Online Ethnography, Pedagogical Agents, Virtual Environments, Virtual Reality.

INTRODUCTION

Background

Virtual Environments and Virtual Reality:

With the development of highly sophisticated computers and graphic systems, a major shift is occurring in the ways people communicate and interact with technology, with information, and with each other. One interactive technology that is seeing dramatic growth is online virtual environments (VEs), defined by Moshell and Hughes (2002) as "…real-time graphical simulation[s] with which the user interacts … within a spatial frame of reference and with user control of the viewpoint's motion and view direction" (p. 893). Thus, VEs are *finite spaces* with specific spatial boundaries; within the boundaries presented, users can move, experience, socialize, work, and learn. VEs also represent *simulations* of locations, real or imagined, and model for users the characteristics of the location they represent. VEs allow users to "visit" and experience simulated locations with as much fidelity as possible.

Virtual environments are a type of virtual reality (VR), which Loftin, Chen, and Rosenblum (2005) identified as a set of "… integrated technologies that provide multimodal display of and interaction with information in real time, enabling a user or users to occupy, navigate, and manipulate a computer-generated environment" (p. 479). Similarly, Davies (2004) identified VR as a "… technique of using computers to model real (or imaginary) environments in a three dimensional space that allows people to interact with the environment in a fashion that is both natural and intuitive" (p. 3). Ausburn and Ausburn (2004, 2008a, 2008b) reported that VR can currently refer to a variety of computer-based experiences ranging from fully-immersive via complex head gear and body suits, to realistic PC-based imagery. They asserted that all types of VR simulate or replicate a 3D environment and give the user a powerful sense of "being there," taking control, and actively interacting with a space and its contents.

Immersive VR technologies and the VEs they create are

complex and very expensive, generally well beyond the technical skills and budgets of most organizations, schools, and instructors. However, new *desktop VR technologies* are technically much simpler and far less expensive and offer the benefits of VR on standard high-quality PC hardware. Desktop VR creates and delivers VEs in either on-screen "movies" or "worlds" that users can "enter" and explore interactively by moving a mouse or other navigation device. The user determines what movements to make and explores the imagery on the computer screen as if actually moving within a place in the physical world. Movement can include panning and rotating the scene to simulate physical movements of the body and head, and zooming in and out to simulate movements toward and away from objects or parts of the scene (Ausburn & Ausburn, 2008b).

Recent advancements in the quality and realism of desktop VR technologies have made them far more appealing and exciting for learning and working. This new quality level, added to the technical and financial accessibility of these new VR systems, make them highly appealing to instructors and organizations who want to transform the way they present learning opportunities (Ausburn, Ausburn, Cooper, Kroutter, & Sammons, 2007). The result has been an increased interest in, and use of, desktop VEs.

One rapidly increasing desktop VR application is online learning via on-screen *virtual worlds* in which participants can enter, search for and interact with information, and engage cooperatively with other participants. One dynamic and rapidly-growing online virtual world is *Second Life*, which was launched in 2003 by San Francisco-based Linden Lab. In this 3D VE platform, users have enormous creative freedom to create, store, and share knowledge by designing their own worlds or building on each other's designs (Ondrejka, 2008). *Second Life* has seen explosive growth, with its 180,000 users in April of 2006 increasing to more than 5,000,000 users worldwide by April of 2007 and a current growth rate of 20 percent per month (Second Life, 2008). This rapid growth of *Second Life* illustrates the increasing popularity of such online virtual worlds as interactive environments and suggests they may have strong potential as collaborative learning tools.

Having conceptual and operational roots in computer gaming, online VEs are by their very nature highly interactive and social in nature. They represent the arrival of highly accessible information and communication technologies (ICTs) that can facilitate replacement or extension of traditional face-to-face collaborative learning with Web-based virtual alternatives (Sobrero, 2008). As Holton and Baldwin (2003) pointed out, this possibility for online enhancement of knowledge creation and sharing has strong potential as organizations increasingly recognize that virtual environments can add value to their processes and opportunities. Edmonds (2007) also supported the potential of online virtual worlds and claimed they could "… take the Internet to the next level, enabling new forms of socialization, communication, collaboration, and commerce" (p. 1). The rapid emergence and growth of interactive online VEs and their acknowledged potential for sharing knowledge through learning, working, and doing business collaboratively suggests that a basic knowledge of the characteristics and features of these tools is needed by both educational institutions and workplaces. This need provided the impetus and established the purpose for this literature review paper.

Types of Virtual Environments

Virtual environments are 3D graphic spaces that users can "walk through", explore, and experience. A critical characteristic that sets VEs apart from other forms of ICT and gives them tremendous advantages is what is generally called *presence* and refers to users' sense that they have actually *been* somewhere rather than just *seeing* it (Di Blas & Poggi, 2007; Mikropoulos, 2006). Di Blas and Poggi (2007) claimed it was this presence that is vital to the effectiveness of VR and causes it to "… intensify, increase, or enhance enjoyment, involvement, task performance and training, persuasion, [and] … memory" (p. 130).

Schroeder (1997) identified two distinct types of desktop VEs, differentiated by their design and user perspective. In

first-person VEs, users view and interact with a 3D virtual world displayed on a 2D computer screen from their own personal observer point of view, moving and exploring within the environment by means of a mouse or other input device in simulation of what they would experience in physical reality. Ausburn and Ausburn (2008b) referred to these first-person desktop environments as *virtual reality movies* under user navigational control. In *second-person* VEs, participants are represented on-screen by graphic figures known as *avatars* and experience the world through their avatars and by interaction with other avatars. These second-person VEs are often called *virtual worlds* or *multi-user virtual environments (MUVEs)* (Nelson & Ealandson, 2008). They are characterized by the presence of avatars; real-time interaction among many users, in-world social activities; tools for users to create in-world objects; and sometimes even in-world currency, commerce; and financial transactions (Edmonds, 2007). An example of a second-person VE/MUVE is shown in Figure 1 which shows a group of avatars working together in a Second Life virtual community.

There are also some interesting variants to Schroeder's first-person/second-person model of VEs. One variant technically has a second-person view because there are avatars, but have a visual display perspective that is closer to first-person. In these VEs (c.f. *worlds.*net), users see the back of the avatar's head most of the time, which is distinctly different from the true second-person perspective in most other virtual worlds. However, when the avatar is commanded to perform actions, users then see the "front" of the avatar. Another VE variant is a hybrid in which users have a first-person perspective of the on-screen environment but are guided or assisted by interacting with an avatar-like on-screen *pedagogical assistant.*

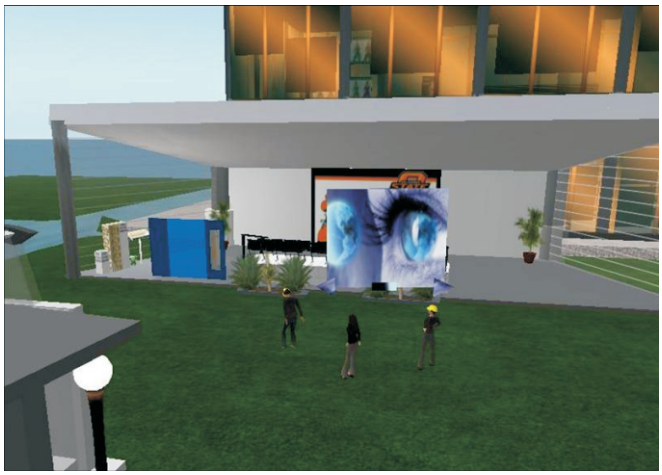

Figure 1. Avatars in a Second Life multi-user Virtual Environment Online

Video Gaming: Foundations of VEs

More than a decade ago Berry (1997) asserted that to see what was next in online technology, one should look to developments in games and gaming. Schroeder (1996) related gaming directly to VEs and claimed that games were at that time spearheading VE development. More recently, Calvert (2002) maintained that because the most common VE experiences were with gaming, games were a focal point for understanding the social impacts of virtual technologies. The accuracy of these predictions is undeniable when one observes the enormous impact that computer gaming has had on cultures and social behaviors worldwide. Badiqué, Cavazza, Klinker, Mair, Sweeney, Thalmann, and Thalmann (2002) moved this discussion to the *online* arena in their assertion that online games are the latest trend in computer gaming and offer totally new and exciting aspects of gaming technology and its impacts. In terms of their conceptual foundations, social characteristics, and technical features, online games are very close media relatives of VEs. In fact, "… the line between a VE and a highly interactive computer game may be simply a difference in interface design" (Isdale, Fencott, Heim, & Daly, 2002, p. 521) and a much lower level of structure and rules of engagement (Schroeder, 1997).

VEs and Social Interaction, Co-operative Learning, and Shared Knowledge Creation

The hallmark features of both VEs/MUVEs (hereafter referred to as VEs in this paper) and their online gaming predecessors are their highly *interactive and social* nature and the *shared creation of knowledge* this nature can create. It is, in fact, capacity for *social interaction* that may make online VEs a significant new tool for cooperative learning, knowledge generation, and information sharing. The interactive nature of online VEs is

based in their technology, which implies interaction of users *both* with other users and with the technology itself. Bracken and Lombard (2004) addressed the importance of human-to-computer interactions in their statement that this interaction "… should be studied not only as mediated communication but also as a new type of interpersonal interaction" (p. 23).

The human-to-human communication that is implicit and enabled in the technology of VEs has dramatic potential for facilitating social interaction, cooperative learning, and shared knowledge creation. The increasing importance of social and cooperative learning in education and business is strongly supported in recent literature. Edmonds (2007) reported that businesses worldwide are already using a variety of Internet tools to facilitate collaborative work and knowledge-sharing among geographically dispersed professionals. He asserted that such cooperative work is likely to become increasingly important in both business and education as VE technology advances and improves. Instructional use of online VEs by schools is strongly supported by a recent survey of teachers by Solomon (2009). In her online *Digital Learning Environments* newsletter, Solomon conducted a "Question of the Month" survey of subscribing teachers that asked, "As the ability to deliver digital content evolves and expands, how will that change the way you and your students access and work with instructional information?" Thirty-six (36) percent of respondents stated that students will work collaboratively on projects. Masie (2009) also recently supported what he called the "rise of social learning and knowledge sharing" through virtual technologies and its positive influences on the ability to adapt learning environments to individual cultures. Masie claimed he was certain "… that as we explore Social Learning, we will find ways of aligning learning more closely to the culture and styles of our learners" (p. 4).

Characteristics of Virtual Worlds and Online Communities-Avatars, Pedagogical Agents and their Populations

Interactive VEs on the Internet are complex *virtual worlds* in which many users can interact simultaneously. These virtual worlds can be extremely complex "cyber settlements," "cyber towns," or "online communities" with all the features, economic structures, and social conventions of places in physical reality. These features can include citizenship, friendship and socializing, community jobs, government, currency, commercial systems, shopping, and land ownership. They also have their own "VR time," a single virtual time zone regardless of the time in which participants live physically. Badiqué *et al.* (2002) proposed that online virtual worlds and communities are particularly interesting because:

"… they offer a radical alternative to real-life communities. They involve large numbers ofgeographically dispersed people. They have access to and thrive on an infinite source of information. They involve people who are mostly complete strangers but yet are friendly with each other" (p. 1147).

To create human interaction in virtual worlds, it is necessary to embody users/participants and to embed them into the world. Bromage (2002) reviewed the theoretical foundations for embodying human beings convincingly in virtual worlds and concluded that this was, indeed, possible. This embodying of human participants and embedding them in virtual worlds is accomplished through the use of figures called *avatars.* Avatars are 3D virtual characters who serve to represent and serve as agents for the human users and to interact with the environment and with other avatars. It is through the eyes of their avatars that participants in second-person VEs experience a virtual world. While avatars can take on any physical characteristics desired, in many cases, they have a similar appearance and behavior to their human counterparts, thus supporting the sense of *presence* as defined above (Badiqué *et al.*, 2002).

An alternative to virtual communities populated with avatars are VEs in which human users are guided and assisted through a learning or work task by figures called *intelligent agents* or *pedagogical agents.* These agents are human-like characters that serve as the interface between computer and user to facilitate learning or task completion. These "guides" are based on artificial intelligence and intelligent agent technology and are actually software programs that identify repetitive

patterns of human behavior and change over time as they "learn" what is expected of them (Feldman & Yu, 1999). Human users can interact with these agents by communicating with them much as they would interact with a classroom teacher, a fellow student, or a co-worker. Like avatars, pedagogical agents create environments that are highly interactive and social. Figure 2 shows an avatar/agent ready to guide a user through a virtual world and its contents.

The embodiment in VEs of human actors in the form of avatars or agents does more than just allow participants to *occupy* or *experience* a virtual world. According to Bromage (2002), it also allows them to *act upon the world,* which raises concern for the consequences that has for social interaction. Moshell and Hughes (2002) agreed with this assertion and pointed out that "… as soon as human forms appear in the world and begin to plausibly interact with the user, behavioral schema shift and become oriented toward shared experiences" (p. 905). It is, in fact, the social interaction created by avatars and agents that give VEs their enormous potential for cooperative learning and shared knowledge creation.

Designing Avatars and Agents

Both avatars and pedagogical assistants/agents are appearing increasingly in online virtual learning environments. Both these techno-figures introduce into screen-based VEs highly social aspects of experiencing and learning through and with interactions with other persona. Both raise issues of how human social interaction occurs and how this is affected by replacing a human-to-human interaction with a human-to-computer one. These issues are critical to designing effective online VEs and to understanding how they function.

Figure 2. An avatar/agent in an online virtual environment

Interactions in virtual working and learning environments are inherently highly social activities. As a result, the success of these computer-based systems depends greatly on the success of the embedded avatars and agents as *social actors*, for it is the social relationship between the human users and computerized agents that motivate and encourage learners to achieve their desired learning goal (Baylor & Kim, 2004; Kim & Baylor, 2006). The social relationships involved in cooperative working and learning are complex and subtle. At issue are multiple decisions that instructional designers must make to create effective computerized social companions for human users, which adds to traditional instructional design considerations, the new issues of social interactions and communication styles. Several lines of research have addressed these issues in designing avatars and agents for VEs. These research lines have focused on (a) how humans and computers interact, (b) social and psychological theories and concepts that underpin this interaction, and (c) impacts of various features of avatars/agent on how human perceive and relate to computer persona. Taken collectively, these research lines have provided some understanding and guidance for designing effective interfaces. Principal concepts, theories, and terminology of this research, and major studies that have addressed them, are presented in the literature which follows.

The CASA theory and paradigm for human-computer interactions.

To guide research on the human-to-computer interactions through avatars and pedagogical agents that define VEs, it was first necessary to develop and validate a theoretical paradigm or model for human-computer interactions. This theoretical foundation has been laid by the *Computers Are Social Actors* paradigm,

commonly known as CASA. CASA theory is basically the study of human-computer interaction research from psychological and communications perspectives that propose that humans interact with computers in fundamentally social ways (Shank, 2008). The CASA theory states that the "social rules guiding human-human interaction apply equally to human-computer interaction" (Nass, Moon, Fogg, Reeves, & Dryer, 1995, p. 223). CASA is now validated by over a decade of research and forms the theoretical basis for treating agents in virtual environments like their human counterparts from the perspective of social interactions (Moon, 1996; Moon, 1998; Nass, Fogg, & Moon, 1996; Nass & Moon, 2000; Nass et al., 1995; Nass, Steuer, Henriksen, & Dryer, 1994; Reeves & Nass, 1996). The CASA theory is particularly important when human-computer interactions change from text-based communication to the insertion of visual images and human-like characters such as the avatars and agents in VEs. Social interactions transform substantially with this media change (Calvert, 2002) because users are now able to not only visit a virtual community, but to actually *act* in it and upon it.

Several social and psychological concepts have been important in CASA research and its findings regarding human-computer interactions. The first concept is *anthropomorphism*, which means assignment of human characteristics to non-human objects. The general finding of the CASA-based research regarding anthropomorphism in VEs has been that increased anthropomorphism of VE agents is associated with increased user satisfaction and performance. Several examples from the research literature illustrate this finding. Sims (2007) found that the presence of realistic human digital characters in VEs significantly improved learner motivation and retention. Similarly, Chittaro and Ranon (2007) reported that the mere presence of a lifelike human character had a positive impact of students' perception of a learning experience. These studies supported previous studies such as Krämer and Bente's (2006) finding that anthropomorphic interfaces induced social reactions from users and elicited communication behaviors that were similar to human-to-human interactions. Koh and Tsay (2006) also found that more anthropomorphic computer figures elicited more politeness toward them by users and supported the notion that similarity between human-to-human and human-to-computer interactions was actually a result of anthropomorphism. However, Baylor and Kim (2003) found that preference for more anthropomorphic agent figures may be different between male and female computer users. In their study, males tended to learn better with more anthropomorphic agents, but for females there was no significant learning difference when learning with more human-like or less anthropomorphic cartoon characters.

Two additional concepts have been important in CASA human-computer interactions because of their relationships to *anthropomorphism.* These concepts are *ethopoeia* and *homophily. Ethopoeia* refers to putting oneself in the place of another to understand and express his or her feelings more vividly. Increasing anthropomorphism in VE avatars and agents may give human users more comfort with and trust in these graphic characters through a greater sense of ethopoeia. *Homophily* or "love of the same" comes from a social communication theory proposed by Lazarsfeld and Merton (1954). The theory posits a human tendency to relate to people who are like us, leading to more communication between a message source and receiver who are alike. The homophily theory was strongly supported by McPherson, Smith-Lovin, and Cook (2001) in an extensive review of over 100 studies showing homophily in various forms and contexts. Several studies have related homophily to anthropomorphism in VE interfaces. Gong (2006) experimented with 12 computer agents at four levels of anthropomorphism and found that as agents became more anthropomorphic, users rated them with higher social presence and higher homophily and regarded them as more persuasive in social influence. Nowak, Hamilton, Hammond, and Krishnan (2007) identified a complex chain of relationships between anthropomorphism and homophily in VE avatars. They found that as avatars increased in anthropomorphism, they were rated by users as more realistic; as avatars' realism rating increased, they were rated as more competent; as competency rating increased, avatars

were rated as more trustworthy; and as trustworthiness rating increased, greater levels of homophily for the avatars were reported.

Taken collectively, this body of research suggests that the inter-relationships among anthropomorphism, ethopoeia, and homophily are complex and that successful interplay among them generally leads to more trust by humans of computer-based characters and more positive feelings about them and satisfaction with computer-based learning. This is illustrated in Figure 3.

Physical characteristics of avatars and agents

Several studies have addressed the relationships of gender, age, ethnicity, and appearance of VE agents with user perceptions and communications. The effects of agent gender on learning and motivation have shown mixed results in experimental studies. Nowak et al. (2007) found that gender matching of avatar and user augmented perceived homophily. Baylor and Kim (2003) reported that user self-regulation and self-efficacy were higher for learners who used male agents. Baylor then later (2007) found that VE users who interacted with female agents tended to have higher emotional outcomes, especially self-efficacy; that male agents were generally perceived as more competent than females; and that interactions with male agents tended to result in greater perception of overall satisfaction with the learning system and agent effectiveness.

Conclusions regarding the effects of agent ethnicity have been formed from several different perspectives. An

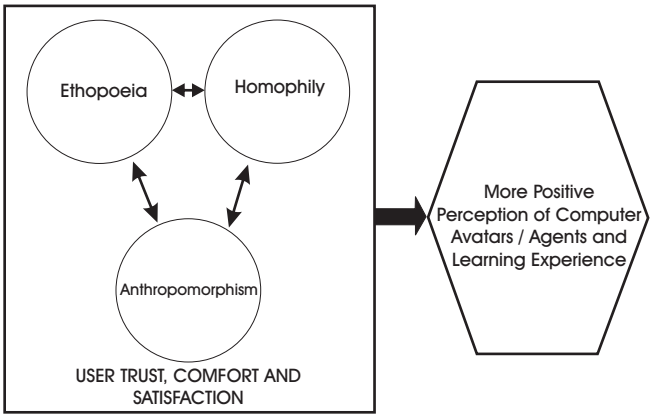

Figure 3. Interrelations and effects on human users of avatar / agent anthropomorphism, ethopoeia, and homophily

experiment by Baylor and Kim (2004) found that when agents play the role of expert, black agents were perceived as more effective than white. Baylor (2007) later asserted that black VE users were more likely to consider agents they chose to be more engaging and human-like than were white users; however, if users chose an agent with like ethnicity, then they considered the agent to be more human-like and affable, as well as more effective in influencing attitudinal outcomes. This finding appears to support homophily theory.

Baylor and Plant (2005) suggested that agent attractiveness could also be important in agent design, at least for young females. In this study, the attribute of "attractiveness" was chosen by female undergraduate students as an attribute for agents they respected, identified with, and wanted as an engineering instructor.

Personality and style of avatars and agents

Several studies have reported findings relevant to the design of the personalities of agents in VEs. According to Baylor (2007), when agents display emotional expressions, this improved message persuasiveness. Gulz (2005) found that some learners preferred more social agents because they were fun, interesting, and provided opportunity to know the character better, while others preferred less social and more task oriented agents because the more social ones could be distracting to the learning task and a tiresome nuisance. Lee, Nass, Brave, Morishima, Nakajima, and Yamada (2007) demonstrated that for at least some learning measures, agents who were "caring co-learners" expressing encouragement and showing empathy toward Japanese students helped build trust and promote learning. Lee, Maldonado, Nass, Brave, Yamada, Nakajima, and Iwamura (2008) found that computer agents who displayed cooperative personalities had positive effects on user performance and also on enhancing the relationship between user and agent by fostering trust in the technology.

Navigation and control of avatars and agents

Successful VEs require not only well-designed avatars and agent, but also good navigational control of these on-screen characters. Di Blas and Poggi (2007) found that the

more control users have over their avatars, the less they are distracted by the technology they are using and the more they focus on the tasks they need to accomplish. However, navigation and control of avatars and agents in VEs is not always easy. A review of navigation instructions for the *Second Life* virtual world makes it clear that moving around by means of one's avatar by walking, running, flying, teleporting, or driving a vehicle can be difficult (Robbins & Bell, 2008; Rymaszewski et al., 2008). In fact, in their presentation of navigation and control instructions to *Second Life* users, Robbins and Bell (2008) stated clearly that "Doing these things gracefully … isn't always easy. And who wants to look like a newbie by crashing into walls all of the time?" (p. 68). It appears that navigating and controlling avatars/agents in VEs can be a design problem and that good training for users in these skills may be required for successful implementation.

Recommendations for Research on Online VEs

As online VEs, avatars, and pedagogical agents continue to become more technologically complex and more widely used, there is significant potential for research to explore the nature and range of social interactions and learning outcomes of human learners with these technologies. While these technologies are promising, it is only through focused research that their benefits can be maximized through effective design and implementation. This paper offers research recommendations in two general areas: theoretical approaches, and research models.

Theoretical Approaches to Research on VEs, Avatars, and Agents

Good research requires sound theoretical foundations. The study of online virtual worlds and the cooperative learning and knowledge sharing they facilitate might be approached from several theoretical areas. One productive theoretical frame might be *organizational knowledge creation and sharing*. The knowledge creation theory proposed by Nonaka and Takeuchi (1995) and Nonaka and Toyama (2003) described knowledge creation through continuous dialogue between tacit and explicit knowledge modes and synthesis by viewing reality through interaction with others who see it differently. This theory might provide appropriate foundations for studying how learners interact to create and share knowledge in online VEs.

Another theoretical approach to studying online VEs might be Bandura's (1977, 2001) *social cognitive theory*, which focuses on the role that models play as influences on social behaviors and posits that people learn from each other by observation, imitation, and modeling. Calvert (2002) pointed out that models from whom one learns can be real people or symbolic media characters, such as those represented by avatars and agents in VEs. Thus, the influences of computer-generated models such as avatars and agents on the social and cognitive behaviors of human users may provide rich theoretical ground for VE research.

Theoretical foundations in human psychological functioning, particularly in how people accomplish *orienting, navigating, and wayfinding,* may provide yet another important reference for studying human learning and behavior in VEs. Based on Lynch's (1960) foundational work on how people find their way around in a city, a considerable body of research has examined how humans are able to find their bearings in both physical and virtual environments. This theoretical body of work may provide particularly useful departure points for examining how learners function in the technical and social worlds of online VEs. The research of Waller and his associates (Hunt & Waller, 1999; Waller, Hunt, & Knapp, 1998) and Darken and his associates (Darken & Sibert, 1996a; Darken & Sibert, 1996b; Darken & Peterson, 2002) provide extensive information about this line of research and its theoretical foundations.

Perhaps one of the richest sources of theoretical perspectives on studying human performance in VEs might be the realm of *individual differences.* Research in many fields have demonstrated profound differences in the ways individuals of different genders, ages, cultures, experiences, psychological states, cognitive abilities, and learning styles react to and perform with various instructional methods and technologies. In fact, Individual differences have been a principal component in

instructional design, cognition, and sociological research on every new medium that has emerged for decades. The design and effects of VEs offer yet another fertile new territory for research based on individual difference theories.

Research Models for VE Studies

For researchers interested in studying VEs, avatars, and pedagogical agents and their effects on human behavior, socialization, learning, and performance, two research models appear to have particular merit. One is the *aptitude-treatment-interaction (ATI) model*. Originally proposed by Cronbach and Snow (1977), the ATI model focuses not on broad undifferentiated effects of instructional methods and tools, but rather on particular interactions between these tools (treatments) and specific differences in the characteristics (aptitudes) of individual learners. Rather than trying to determine if an instructional medium is "good" or "bad", ATI research asks how a specific learning task, treatment, and type of learner might "interact" such that a treatment might be effective for one type of learner but ineffective for another. It seems intuitively likely that learners with different characteristics may react to and perform differently in VEs, and there are a great many theories of individual differences that could provide support for such a conjecture. Thus, the ATI research model appears particularly appropriate for research on this emerging technology.

The second research model that may be highly beneficial for studying online VEs is the *anthropology or ethnographic model.* This model is concerned with observing and documenting the attributes and behaviors of an environment as a *culture* and posits that online VEs actually possess many of the attributes of a culture such as community, language, economics and commerce, politics, gender roles, race and ethnicity, customs, history, social conventions, heroes and legends, and rites of passage. Boellstorff (2008) supported this view of VEs as cultures and the use of ethnographic methodology to study them. In his review of the history of what he called "cyber sociology research" (p. 53), Boellstorff pointed out that his online ethnography of the culture of *Second* Life was preceded by other ethnographies of 3D virtual worlds such as *World of Warcraft, Habitat,* and *Active Worlds.* Studies of text-based computer-mediated communication (CMC) applications made during the mid-1990s were some of the first studies to view the Internet from a cultural context. These studies began with a psychological approach based on experimental methods, then moved to viewing the Internet and its applications from a cultural context through the use of ethnographic methods of immersion, observation, documentation, and interpretation of cultural-social aspects. Bellstorff reported there are currently active discussions regarding the ways to best maximize the use of ethnography studies for examining the cultures of virtual worlds. He supported "online ethnography" as a methodology for analyzing what he called an "electronic tribe" (2008, p. 53). Masie (2009) recently supported the concept of online environments as cultures for learning and working. He used similar terminology to Bellstorff in referring to the rise of "social learning" on the Internet and linking it to the role of "the tribe" in knowledge sharing. Masie spoke of the importance and benefits of social learning in online environments and raised the challenge of using:

"… the metaphor of the tribe in social learning linking it to the more historical role of elders and peers in the learning process. Imagine the ability of designing a tribe for a learning activity - creating an intentional cluster of people that will enhance, extend and structure the social component of learning" (p. 4).

Conclusion

Current literature indicates that online virtual environments are an important emerging technology for learning and working, and that their characteristic features of human-like avatars and pedagogical agents and real-time interactions among large numbers of users enable them to engender highly cooperative and social behaviors and outcomes. The state of the research appears to support Edmonds' (2007) contention that this is an important technology that can "… take the Internet to the next level, enabling new forms of socialization, communication, collaboration, and commerce" (p.1) and have a significant impact on both education and business.

Analysis of current usage and numbers of online VEs suggests that Edmonds was accurate in his claim that online VEs are presently where the World Wide Web was in the early 1990s and are in their early stages of development. If this emerging technology for online cooperative learning and working is to reach its potential and mature as an effective tool, much will need to be learned about how it works, why it works, when it works, and how to design its interaction components for maximum effectiveness. This paper represents a first step in acquainting instructional designers with the concepts, issues, and possibilities of online virtual worlds, avatars, and pedagogical agents. Extensive research using aptitude-treatment-interaction (ATI) designs and online ethnography concepts and techniques is needed to understand and capitalize on the capabilities of online VEs and the social interactions and shared learning opportunities they present.

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